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WFQ ENHANCEMENT USING INTELLIGENT DISTRIBUTED QUEUE BASED ANFIS FOR PACKET SWITCHING NETWORK

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Abstract. The proliferation of the Internet and its applications has led to a potential increase in users' requests for more services at economical prices and Quality of service. The diversity of Internet traffic requires some prioritization and prioritization because some visits deserve great attention while reducing delays and packet losses compared to others. Current swap scheduling mechanisms are characterized by three main characteristics: fairness, complexity, and protection. Therefore, the question remains how we can provide equity and protection with less complex implementation. In this paper present proposed scheduling mechanism to enhance the performance of computer network. Proposed method is utilize an adaptive neural fuzzy inference system in make schedule decision and adapted to handle with varying behaviors of network. It is programmed in object oriented programming C++ with OMNET++ environment. The proposed method ANFIS solving the problem of complexity run time for WFQ algorithm. It uses ANFIS to calculate the virtual finish time for packets instead of mathematically way in the ordinary WFQ. The main contributions of this paper are minimizing the delay, reduce the packet loss in routers service queue and increasing throughput. In order to enhance the performance of computer network.

Keywords: congestion Control, packet scheduling, Queue Limitation, ANFIS, WFQ algorithm.

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based anfis for packet switching network
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Introduction

The network represents in a graph of nodes linked to gather by network links. The traffic network is a set of queues deployed in the network nodes (devices) [1]. The network devices supply a contact among networks, and working to keep the broadcast traffic controlled. Essentially, the packets are received by network devices such as routers from source (sender). The packets wait their turn in devices queue to serve according to the queuing policy before, forwarded to the pre-specified destination (receiver). Over the transmission of packets congestion might be occur caused by traffic overflow, which makes some traffic get loss. Therefore, the router is to choose the best method to schedule the efficiently traffic, to minimize the dropped packets [2].

In present days most of computer networks work by support of the best effort services which deal with the packets on a «first in – first out» service policy without quality guarantee. This type of network service is not convenient with the multi types of traffic such as video, voice, and text which belong to different transmission protocols. Some of these types of traffic need the reliability and careless in delay, other type effected with delay and needless the reliability. Hence, the release of Quality of Service (QoS) concept is needed to provide more efficient performance and support multimedia traffic with QoS guarantee [3]. Packet scheduling is one of the major mechanisms in traffic control to avoid traffic congestion. In additional, it is one of essential QoS mechanisms which accountable for chosen the user's data flows and the next transmission for their packets of data flow. The data Packets are transmitted from the user's queues to their destinations based on decisions of scheduler. Hence, packet scheduling is a process that manages the network bandwidth by monitor the preference and requirement of data packets based on the precedence of the packets by giving to the packets higher priority or lower priority [4, 5].

Packet scheduling performs a substantial role in providing different classes service QoS guarantees, which involves bounded delay, high throughput and fairness bandwidth allocation among data flows. Therefore, a packet scheduling algorithm is really necessary to decide which packet to depart next process when multiple users of a network share the same link. That means packet scheduling algorithms are required to prioritize network users to meet QoS support by making use of network resources. The main objective of packet scheduling is sharing the available resources among all share system participants in order to meet the predefined policy [6].

Weighted Fair Queuing (WFQ)

The first packet scheduling approach successes to get an ideal approximation to GPS model in terms of a packet fairness level is known as Weighted Fair Queuing (WFQ) also named as the Packet by packet Generalized Processor Sharing (PGPS). But it does not assume a small amounts of data flow to transmit as well as GPS model. WFQ approach is well known in the networks based on wireline broadband and low-speed traffic (2 MB). It produces bandwidth service guaranteed among the multiple users. Therefore, WFQ designed to guarantee that each flow get fair sharing to the network resources and prohibit the bursty flows to get more unfair consuming more than its proportional share bandwidth capacity, where present guaranteed throughput, fairness, and bounded delay [7]. The standard WFQ algorithm is worked based on several assumptions can be uttered as follows: The traffic is divided into multiple flows [8]. The packets are needed to be send and received (transmitted) as entities. After computing the multiple finishing times stamps of the multiple connections, the WFQ scheduler will be select the packet which has the smallest finishing time stamp from their flow for the next transmission output process.

Adaptive Neural Fuzzy Inference System (ANFIS)

Adaptive Neural Fuzzy Inference System (ANFIS) is one of the most successful and effective schemes of neural-fuzzy systems that integrate the advantages of these two powerful schemes into a single scheme [9]. It is a hybrid system that operates by applying the rules of Neural Network (NN) learning to identify and tune the parameters of memberships functions for the scheme of a Fuzzy System.

The main idea behind design hybrid integration system is to produce a system that uses a fuzzy system to represent knowledge with more ability to tune their parameters of memberships function. Also to modify fuzzy linguistic IF-THEN rules according to work environment and have the ability to the learne obtained from a neural network to enhance the performance of adaptive system [10, 11]. The five layers of ANFIS are shown in Fig. 1.

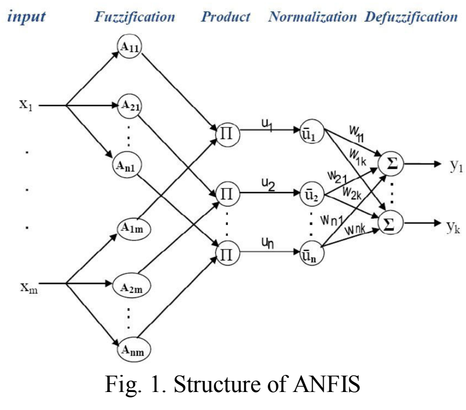

Fig. 1. Structure of ANFIS

The proposed method

WFQ algorithm is designed to emulate the model of GPS system, which is the ideal system for the fluid-flow of data in the network. Also to present an effective scheduling, high level of fairness and better link utilization in the case of the packets sizes of incoming flows are varied. The algorithm has achieved good performance of the network and a satisfactory degree of fairness. But it still has challenges as it is not quite close to the ideal GPS mode and there is the problem of complexity in implementation time and delay in waiting queues. The complexity time arises because of the WFQ algorithm calculates the virtual start and finish time for each packet in the network which drives a burden on the scheduler.

Therefore, the wf2q algorithm is proposed to enhance the WFQ and achieved good scheduling results and better emulate for ideal fluid system GPS model [8]. Although, they remain suffer from the issue of complexity execution time. Complexity is one of the influenced properties in scheduling algorithms. As the time is very important in the speed of transportation of data in the network, scheduling algorithm properties must be fast, protected and less complexity timeframe for implementation in order to provide efficiency in the transference of packets speed.

An intelligent scheduler is proposed to solve the problem of high complexity in the implementation time of the WFQ algorithm, packet loss, and delay by using fuzzy neural network which are less complexity time and more flexible to treat with the different flows utilizing the fuzzy rules base involved in ANFIS to adjust and convention parameters of network. It emulates the WFQ work and utilizes the same parameters relying on the ANFIS system. Proposed scheduler (ANFIS) determines the virtual finish time for packets using fuzzy neural network that are improved less run time complexity. The incoming flows are classified by classifier into several services queue according to their priority or data types. Each service queue has a weight that represents the rate of bandwidth sharing. Then a scheduler determines the virtual finish time for each packet in service queues and select the packet that has less finish time from queues in every round. ANFIS scheduler depends on three inputs and a single output as it's illustrated in Fig. 2.

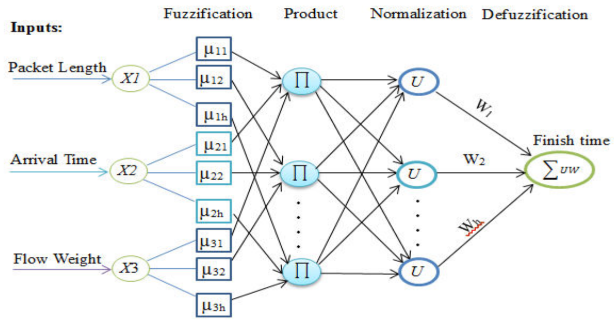

Fig. 2. Structure of ANFIS Scheduler

The product layer is to multiply all the incoming fuzzy values together to obtain the antecedent part of the rules. The variable h is considered as a unit of product and normalization layers and also represent the number of fuzzy rules where $h = 48$. The number of rules and the product layers determined by multiply the number of first input membership functions with second input membership function and third input membership functions. The rule based on the fuzzy inference system ANFIS1 is illiterated in the Tab. 1.

Table 1. **Rule Base of ANFIS**

Packet length		Small	Medium	Big	V. Big
Packet arrival time	Flow weight				
Early	Low	Low	Low	Med	Med
	Med	Low	Low	Med	Med
	High	Low	Low	Med	Med
Medium	Low	Low	Med	Med	Med
	Med	Low	Med	Med	Med
	High	Low	Med	Med	Med
Late	Low	Med	High	High	V. High
	Med	Med	High	High	V. High
	High	Med	High	High	V. High
V. Late	Low	V. High	V. High	V. High	V. High
	Med	V. High	V. High	V. High	V. High
	High	V. High	V. High	V. High	V. High

Implementation and Results

The proposed method is applied on a computer network and consists of 18 nodes as shown in Fig. 3. In ANFIS proposed method, the Gaussian function is utilized to perform the fuzzification process for membership functions. ANFIS method is trained by backpropagation algorithm, when the parameters (weight, center and width) are adapted to minimize the mean square error function.

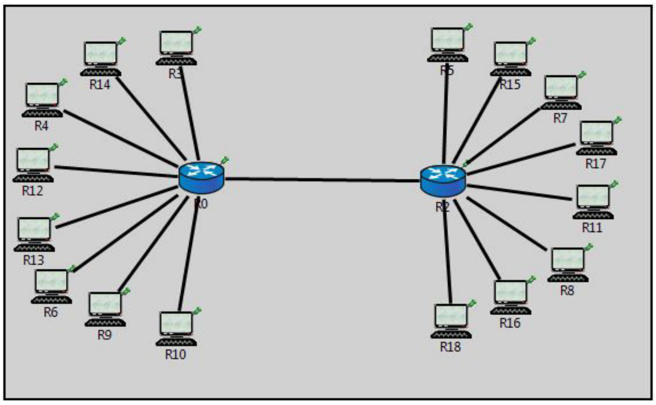

Fig. 3. Computer network form

There are 30 sets of training patterns are used. The training procedure continues, till the value of mean squared error (MSE) arrives at acceptance minimum error. In the training stage, the obtained results are noticed and proved that the MSE is decreasing directly proportional with increasing the number of epochs as shown in Fig. 4.

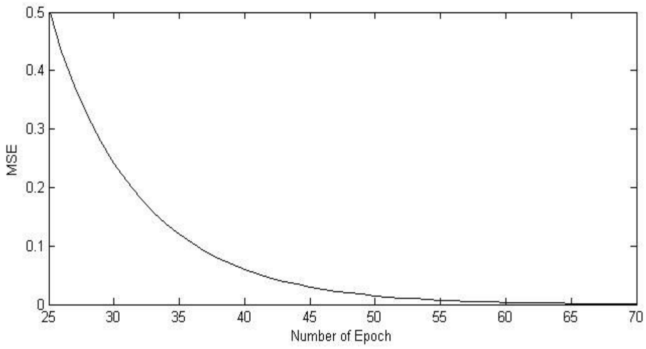

Fig. 4. Error versus number of epochs of the ANFIS

The testing is performed on the trained sets and on other test sets for the computer network. Some of the results of the testing are exposed in Tab. 2. The results are summarized in Tab. 3, which shows the efficiency of the performance of the fuzzy neural networks through the testing. This Table describes the success rates to test trained sets and test sets.

Table 2. **Samples of testing results for ANFIS**

Inputs of ANFIS			Output of ANFIS
Packet length	Arrival time	Flow weight	Finish time
1.2	0.8	0.42	2.44
1.2	9.8	0.12	7.69
9.2	2.8	0.73	10.5
3.8	2.2	0.32	5.61
7.8	8.2	2.2	11.7
4.2	9.8	0.22	12.8
9.2	8.8	0.5	15.4
6.2	13.8	0.58	17.6
7.8	14.2	0.28	16.4
5.8	10.8	0.28	14.2

For instance, the first service queue allocates a value equal to 0.5 where this value simulates membership function which in the linguistic term is Med. The second and third service queues allocate a values equal to 0.25 where this value simulates membership function which in the linguistic terms are Low and Med. If the first packet in the first flow arrives in a time equal to 1 where this value simulates membership function which in the linguistic terms are Low and Med; and the packet length is equal to 2 where this value simulates membership function which in the linguistic term is Low the virtual finish time 3 where this value simulates membership function which in the linguistic terms are Small and Med. Also in case of, the first packet in the second flow arrived in a time equal to 1 where this value simulates membership function which in the linguistic terms are Low and Med, and the packet length equal to 2 where this value simulates membership function which in the linguistic term is Low. Then the virtual finish time as result of ANFIS1 is equal to 4 where this value simulates membership function which are the linguistic terms are Low and Med. Another case, If the first packet in the third flow arrived in 1and has length 3 the virtual finish time is 5 where this value simulates membership function which in the linguistic terms are Small and Med. Finally, the scheduler choice the packet has less virtual finish time to send next, which is the packet from first flow that has virtual finish time is equal to 3 where this value simulates membership function which in the linguistic terms are Small and Med.

The simulation results illustrate the most important and effective parameters that have a significant effect on the performance of the network. The parameters that are shown in the tables and bar charts of results are the delay, packet loss and throughput. In the Tab. 3 a comparison between the proposed method ANFIS with the traditional WFQ is illustrated. ANFIS act better than WFQ as shown in the table below. The bar chart shown in Fig. 5 illustrate clearly the varying in the results values for WFQ versus ANFIS1, where bar chart explains the parameters for each computer networks independently.

Table 3. **The ANFIS delay, packet loss and throughput in comparison with WFQ**

No	Method	Delay (second)	Packet Loss	Throughput
1	WFQ	1.63	0.18	0.82
2	ANFIS1	0.17	0.05	0.95

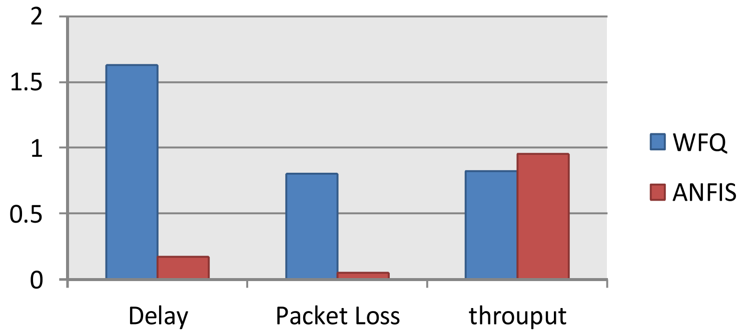

Fig. 5. Comparison ANFIS versus WFQ

Conclusion

In this paper, scheduling of queues service of computer networks in routers and solving the problems of delay and packet loss are discussed. Therefore, novel method for modeling scheduling by implementing the fuzzy inference system inside an adaptive neural fuzzy inference system approach has been proposed. In the proposed method ANFIS, noticed that minimization of the complexity running time for the WFQ algorithm has an important role in determine the delay for network. Where, the minimizing of complexity time led to reducing the waiting time for packets in the service queue. Consequently, it has been driven to minimizing the delay rate and packet loss in a computer network.

References

1. Manion M. McGraw-Hill encyclopedia of science and technology // Reference & user services quarterly. – 2002. Vol. 42, № 2. P.178–179.
2. Manmadhan S. Fuzzy logic based traffic management for high speed networks // International journal of scientific research. 2014. Vol. 3, № 5. P. 187–189.
3. Goyal M., Lather Y., Lather V. Research article modelling & simulation of queuing disciplines over the N/W carried applications (Ftp , Video and Voip) for traffic dropped & time delay // Internation journal of

computer science and mobile computing. 2015. Vol. 4, № 1. P. 562–570.
4. Meiners C.R., Liu A.X., Torng E. Hardware based packet classification for high speed internet routers. Springer Science & Business Media, 2010. 123 p.
5. Golaup A.A., Holland O., Hamid A. Aghvami packet scheduling algorithm supporting multimedia traffic over the HSDPA link based on early delay notification // 1st International conference on multimedia services access networks. MSAN05, 2005. P. 78–82.
6. Miaji Y.S.A. Just queuing: Policy-based scheduling mechanism for packet switching networks. Universiti Utara Malaysia, 2011. 247 p.
7. Galshetwar G.M., Jayakumar P.A., Mittal Y. Comparative study of different scheduling algorithms for Wimax MAC scheduler design // International Journal of Engineering Research and Applications (IJERA). 2012. Vol. 2, № 2. P. 1031–1037.
8. Balogh T., Medvecký M. Performance evaluation of WFQ, WF 2Q + and WRR queue scheduling algorithms // 34th International conference on telecommunications and signal processing (TSP), 2011. P. 136–140.
9. Kurnaz S., Cetin O., Kaynak O. Adaptive neuro-fuzzy inference system based autonomous flight control of unmanned air vehicles // Expert Systems with Applications Elsevier Ltd. 2010. Vol. 37, № 2. P. 1229–1234.
10. Patel J., Parekh F. Forecasting rainfall using adaptive neuro-fuzzy inference system (ANFIS) // Ijaiem. 2014. Vol. 3, № 6. P. 262–269.
11. Classification of the liver disorders data using multi-Layer adaptive neuro-fuzzy inference system / P. Tavakkoli [et al.] // 6th International Conference on Computing, Communications and Networking Technologies, ICCCNT, 2015. P. 1–4.

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